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7486 CERAMIC TRIODE

PRODUCTION ENGINEERING MEASURE

SECOND QUARTERLY PROGRESS REPORT

1 OCTOBER 1962 THROUGH 31 DECEMBER 1962

CONTRACT NO. DA-36-039-SC-86738

UNITED STATES ARMY SIGNAL SUPPLY AGENCY

PHILADELPHIA, PENNSYLVANIA

CLASSIFICATION - NONE

RECEIVING TUBE DEPARTMENT

GENERAL ELECTRIC

OWENSBORO, KENTUCKY

7486 CERAMIC TRIODE, PRODUCTION ENGINEERING MEASURE

SECOND QUARTERLY PROGRESS REPORT

1 OCTOBER 1962 THROUGH 31 DECEMBER 1962

Objective: (1) To provide improved vacuum exhaust equipment for processing 7486 tubes.

(2) To improve tube ratings by evaluation on new test equipment.

(3) To increase tube life expectancy by improved tube design features.

(4) To demonstrate 100 tube per day production capability.

(5) To prepare and distribute progress reports.

(6) To prepare the Step II report covering a rate of 10,000 tubes per month.

CONTRACT NO. DA-36-039-SC-86738

SIGNAL CORPS INDUSTRIAL PREPAREDNESS
PROCUREMENT REQUIREMENTS NO. 15

CLASSIFICATION - NONE

REPORT BY - J. D. MARSHALL

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1.0 ABSTRACT

Design of exhaust equipment has been completed and orders have been issued for components. Special test equipment has been completed. Life tests have been started for evaluation of the present product. Complete results of heater design changes are not available. Tests on effects of new cathode spray masks are still in progress.

2.0 PURPOSE

One of the objectives of this contract is to provide improved tube processing equipment capable of producing 100 tubes type 7486 per day. The principal improvement in processing will be to fire component parts and seal tubes on ion pump exhaust equipment. Other improvements in cathode spray equipment and assembly jigs and fixtures are expected to improve the uniformity of the product. By evaluation under various conditions on new test equipment it is intended to reflect the benefits of this work in improved ratings of this tube, particularly in the areas of high frequency performance, and to give assurance that these ratings will be compatible with stable performance during life.

This evaluation includes life testing at increased values of plate dissipation and cathode current, under 450 megacycle conditions. Performance tests will also be conducted at 2200 and 5900 megacycles.

Design modifications will be made to the heater to assure longer life. The advantages of tungsten-rhenium wire and darkened insulation coating will be demonstrated.

The test requirements for the improved tube are defined by the SCL-7001/74 specification dated 24 May 1962.

3.0 NARRATIVE AND DATA

3.1 TASK I - VACUUM EXHAUST EQUIPMENT

A request for bids was issued to three suppliers of vacuum equipment once the design had been completed. An order was placed with the Ultek Corporation for the complete unit with dual exhaust and sealing chambers. The selection was made after considering price as well as compatibility with design criteria such as pumping speed and valving.

The design includes a basic stainless steel bell jar type chamber with an Ultek 20/60 Boostivac roughing system. The high vacuum pump is to be a 400 liter per second ion pump with Boostivac elements that increase its pumping speed to 4000 liters per second.

This system is to be ready for inspection by General Electric at Palo Alto by March 15, 1963, and should be in Owensboro by March 29, 1963. It will be installed at its operating location in order to eliminate some waste time and effort in another moving operation following prove-out as was originally planned. The possibility of damage during such a move is also eliminated.

3.2 TASK II - TEST EQUIPMENT

3.2.1 - 450 MC LIFE TEST

Construction of 50 positions of 450 Mc life test has been completed. Fifty tubes from the 325 tube group

mentioned in the last Quarterly Report, (3.2.7, p 9), were installed in this equipment, with 10 tubes subjected to each of the five test conditions listed in Table I. These tubes have completed 100 hours of life with one inoperative failure at 86 hours on Condition 2.

Condition	Eb (Volts)	Ip (ma)	Ig (ma)	P(in) (Watts)	Po (Watts)
1	150	7	3	1.25	0.6
2	150	10	5	1.5	0.85
3	200	15	7	3.0	1.8
4	250	15	6	3.75	2.3
5	350	20	8	7.	4.2

Table I 450 Mc Life Test Conditions

3.2.2 - 60 CYCLE LIFE TEST

Construction of 100 positions of 60 cycle life testing equipment has been completed. Conditions were established comparable to those reported above for 450 Mc life. The 60 cycle life test conditions are found in Table II. One hundred tubes have been installed from the 325 tube sample already described, with twenty tubes to be tested at each of the five test conditions. These tubes completed 500 hours of life during the first week of January. There were eight failures during that period, but only four have been returned for analysis at this time. A more complete summary of this test

will be presented in the next Quarterly Report.

Condition	Ep (Volts rms)	Ik (ma)	Ig (ma)	Rg (Ohms)	Pw (Watts)
1	130	11	1.	6800	1.5
2	103	15	2.5	2200	1.5
3	130	16	2.3	2700	2.0
4	150	17	2.5	2700	2.5
5	130	21	3.5	1600	2.5

Table II 60 Cycle Life Test Conditions (eg = 14V)

3.2.3 - 2200 MC AMPLIFIER CAVITY

The evaluation of the 7486 tube in the amplifier cavity shown in the last Quarterly Report was continued. The conditions in the specifications SCL-7001/74 dated 24 May 1962 and shown below were used as a starting point.

F = 2200 Mc
Ebb = 250 Vdc
Pd & Rb/Ib = 13 mAdc
Gain = 5 db
Po = 25 mW

The gain and power output figures given indicated that the RF driving power should be approximately 8 mW. Using this driving power figure with the above conditions of supply voltage and plate current gave an average power output of 175 mW for 10 sample tubes. This represents a power gain of 13.4 db showing that the tube is capable of considerably better performance than anticipated in the specification. The applied

plate voltage for these 10 sample tubes averaged 210 volts measured on the plate side of R_b.

To further explore the tube's potential in this circuit, drive power versus power output and gain curves were taken at a plate voltage of 200 Vdc and at two values of plate current, 13 mAdc and 18 mAdc. The results are shown in Figures 1 and 2.

From these data, tentative test conditions have been established. Final test conditions and tube ratings will be set upon the completion of sufficient life testing of tubes from the pre-production run. These tentative test conditions are:

Ef = 6.3 Vac
Eb = 200 Vdc
Ib = 13 mAdc
Ic = 2 mAdc (max)
F = 2200 Mc approx.
R_g = 1000 ohms
P_d = 50 mW
Vary R_k for I_b = 13 mAdc
Tune input and output cavities and loading for max Po
Record Po, gain, and 3 db bandwidth
Po = 350 mW min
Gain = 8.4 db min

3.2.4 - 5900 MC OSCILLATOR CAVITY

The final test cavity design is shown in cross-section in Figure 3. This is a re-entrant circuit optimized for the 7486 at 5900 Mc and tuneable around this frequency.

Fifty tubes were evaluated in this cavity and the results

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Figure 1

7136 Operating Performance Curve

f = 2,200 Mc.
Ef = 6.3 V. AC
Ebb = 200 V. DC
Ip = 13.0 mA

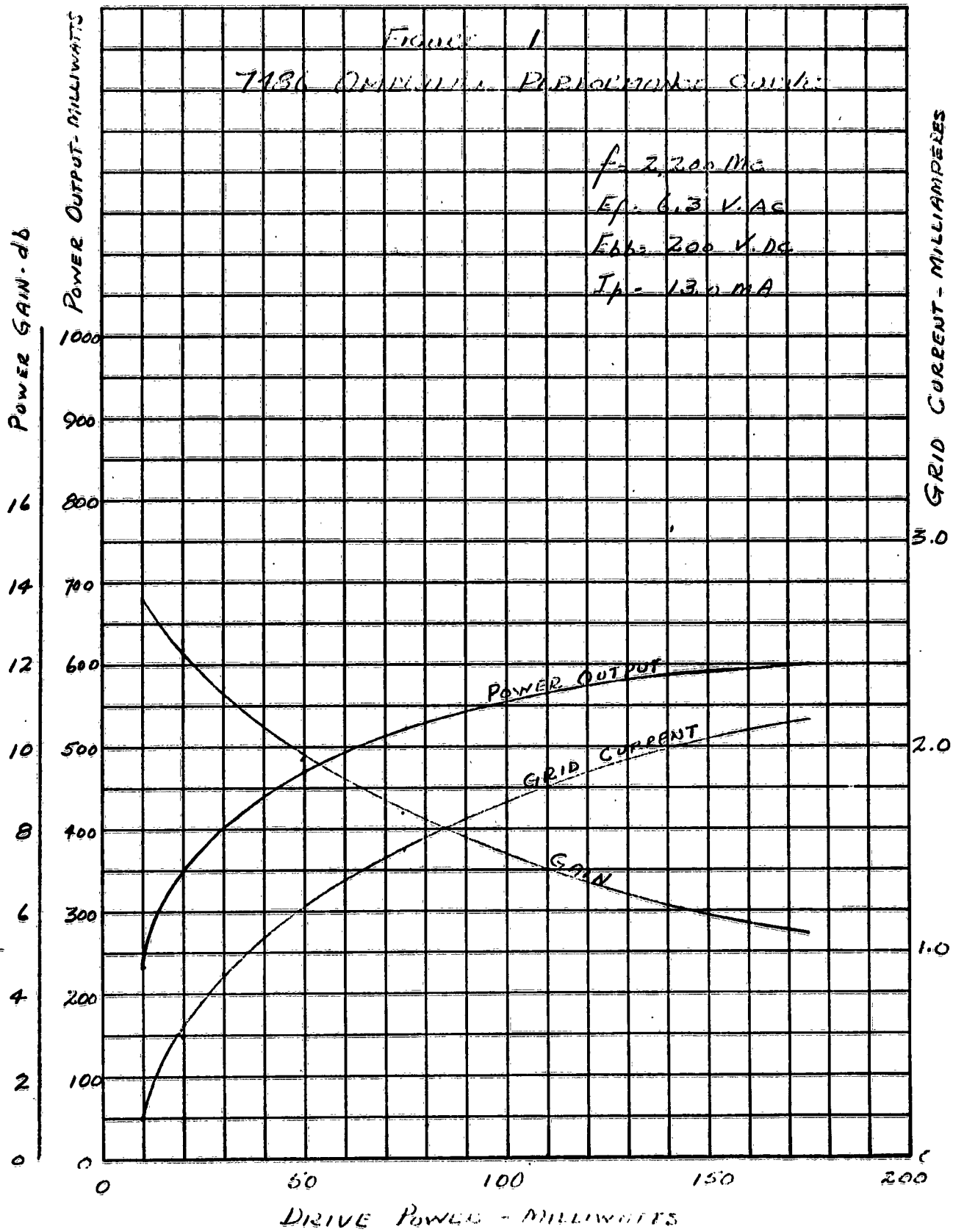

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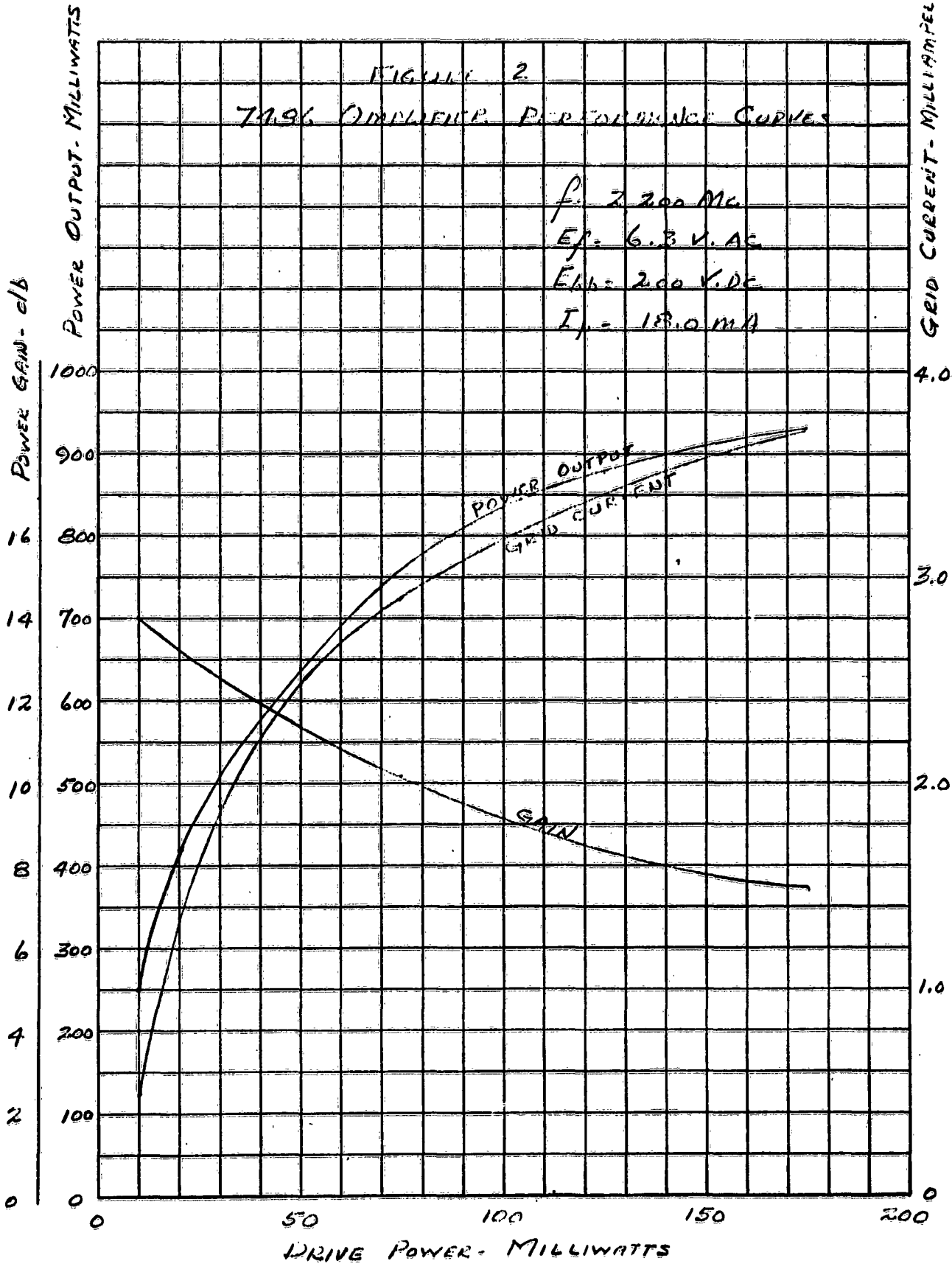
FIGURE 2

7289 OSCILLATOR PERFORMANCE CURVES

f = 2 200 Mc.
E_f = 6.3 V. AC
E_{bb} = 200 V. DC
I_p = 18.0 ma



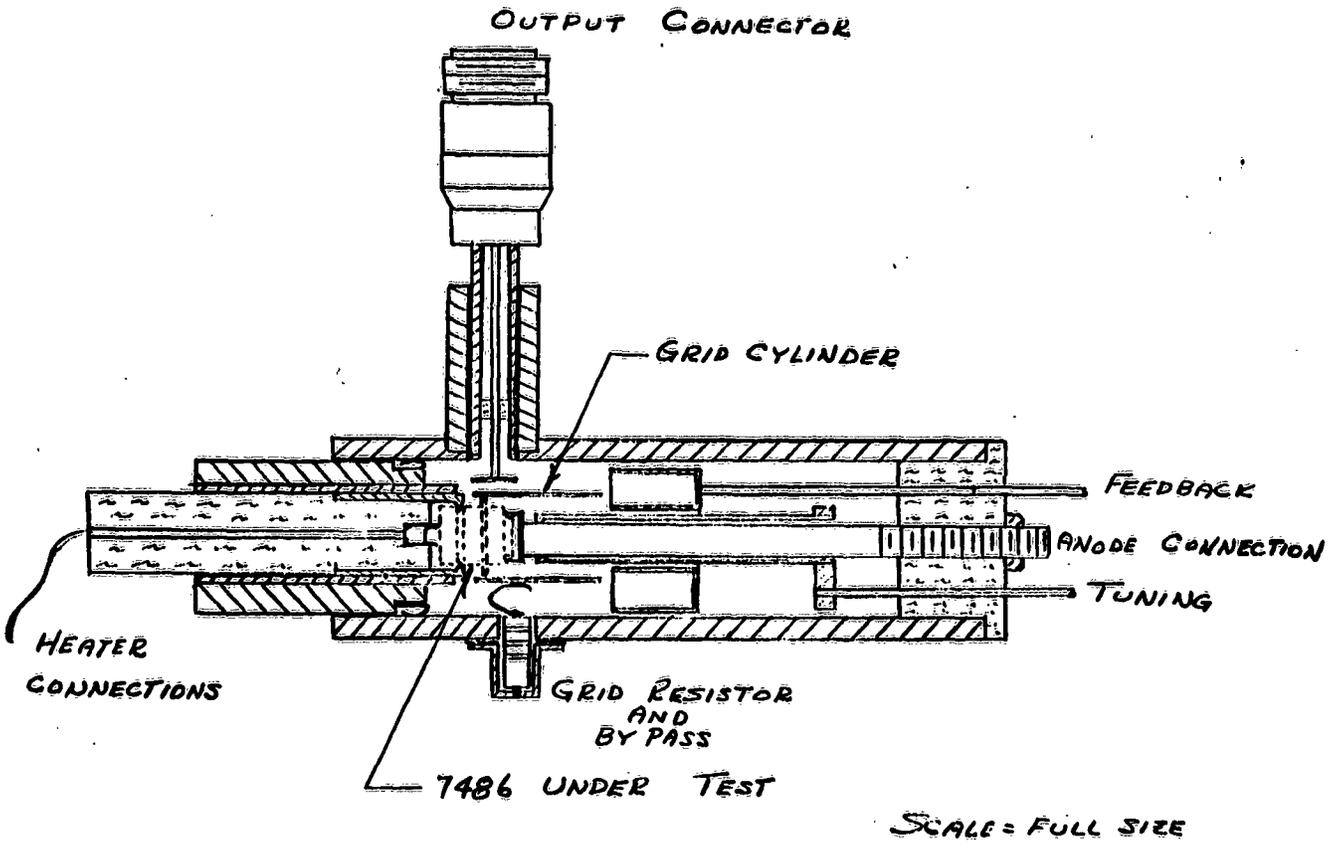


FIGURE 3 - 5,900 MEGACYCLE OSCILLATOR FOR 7486 OSCILLATION (Z) TEST.

of the power output test are shown graphically in Figure 4. These tubes gave an average power output of 35 mW with a minimum of 13 and a maximum of 43 mW when tested under the following conditions:

F = 5900 Mc approx.
Ef = 6.3 Vac
E_{bb} = 200 Vdc
R_k/I_b = 13 mAdc
I_c = 2 mAdc max.
R_g = 2200 ohms
Adjust cavity for maximum Po at 5900 ± 50 Mc with a standard tube having Cgp and Cgk within 2% of bogie.

It was found that after setting the cavity as above only minor peaking of the output coupling was necessary when changing tubes. No adjustment of the feedback was required. It is proposed that the tubes be tested at a constant plate current of 13 mAdc and that this be set by varying the cathode bias.

On the basis of the tests on these fifty sample tubes, a minimum power output of 10 mW under the above specified test conditions appears to be a reasonable objective, rather than the 5 mW minimum proposed in the SCL-7001/74 specifications.

3.2.5 - ENGINEERING SAMPLES

The first lot of engineering samples is due to be shipped on February 19, 1963. These will be tubes of the present design which were withdrawn from a production lot of type 7486. The tubes to be supplied will be tested on the new equipment

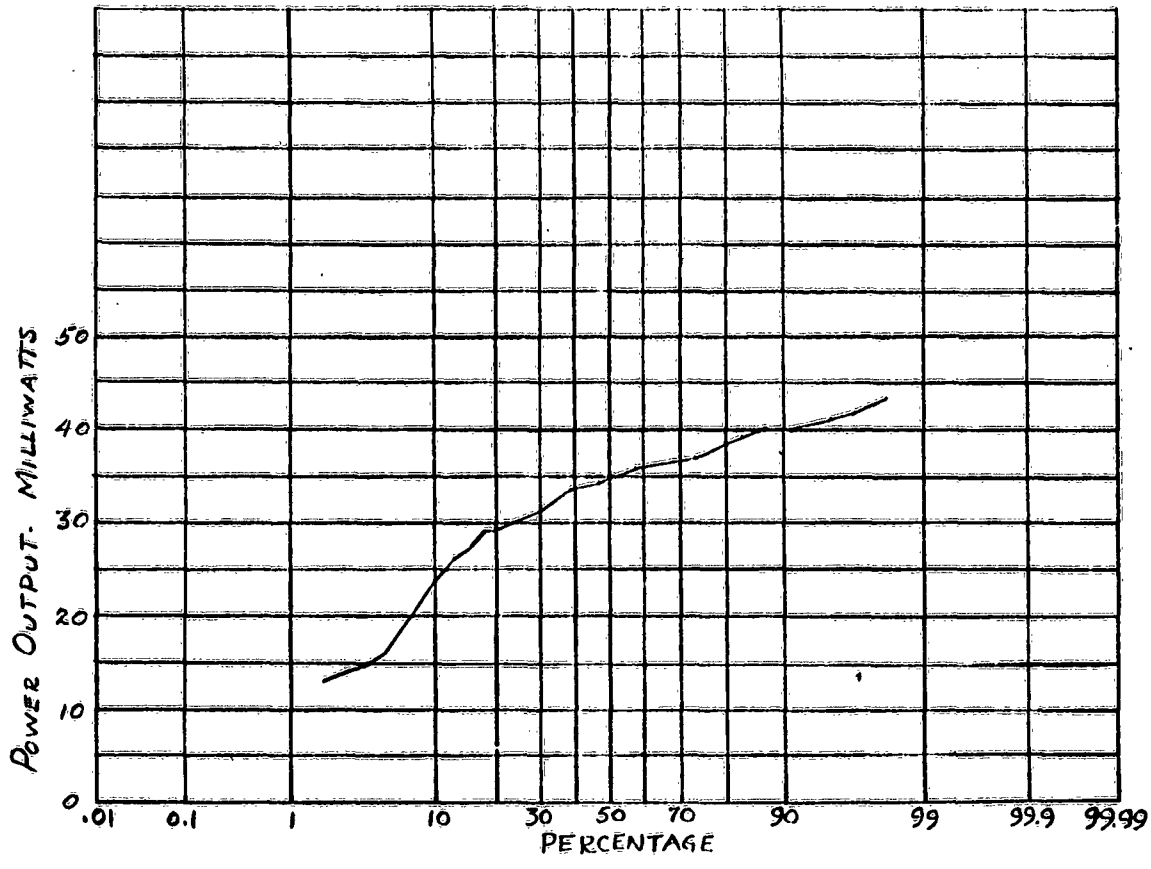


FIGURE 4 - PROBABILITY CURVE FOR 7486 POWER OUTPUT UNDER OSCILLATION (Z) CONDITIONS AT A FREQUENCY OF 5,900 MEGACYCLES PER SECOND. (50 TUBES)

described in Section 3.2. These tests should be completed during the month of January. The sample will be held until life test data are available. This will not delay delivery of the sample.

3.3 TASK III - TUBE DESIGN IMPROVEMENT

3.3.1 - HEATER DESIGN

Results of heater design changes will be delayed due to late arrival of heater coils. Construction of tubes was to be completed by the end of January. This will now carry over to include the first week in February. Life testing and evaluation may also be delayed a like period to the first week in March. The schedule can still be maintained by an added effort to complete the construction of tubes incorporating design improvements within that assigned period.

Analysis has begun on tubes subjected to progressive stress heater-cathode life. There were fewer failures in each of the three lots of tubes with "darkened" heaters. The breakdowns are not always evident, but the spot at which most visual effects of failure were found is at the top of the coil nearest to the cathode lid. The failures on tubes with normal "white" heaters occurred more randomly over the coated surface.

3.3.2 - CATHODE COATING TECHNIQUES

A delay was also encountered in the cathode spraying phase.

This was due to the appearance of a higher percentage of failures in all production lots on testing for grid recovery. The first lot of 90 tubes was not placed on life test for this reason.

Life tests on other lots have been conducted at higher envelope temperature (250°C) which is designed to accelerate changes in tube parameters. One such test consists of reducing the heater voltage (6.3 volts to 5.7 volts) while observing a change in transconductance. There was a higher percentage of change for this characteristic within the lots of tubes made with cathodes which had been sprayed with the overhanging lip type of mask. There was a reduction of the accumulation of cathode coating in undesirable areas which was the purpose of the design.

The use of the second spray mask design, consisting of a beveled fit, also reduced the accumulation of cathode coating in undesirable areas. The initial tests for electrical characteristics appear favorable.

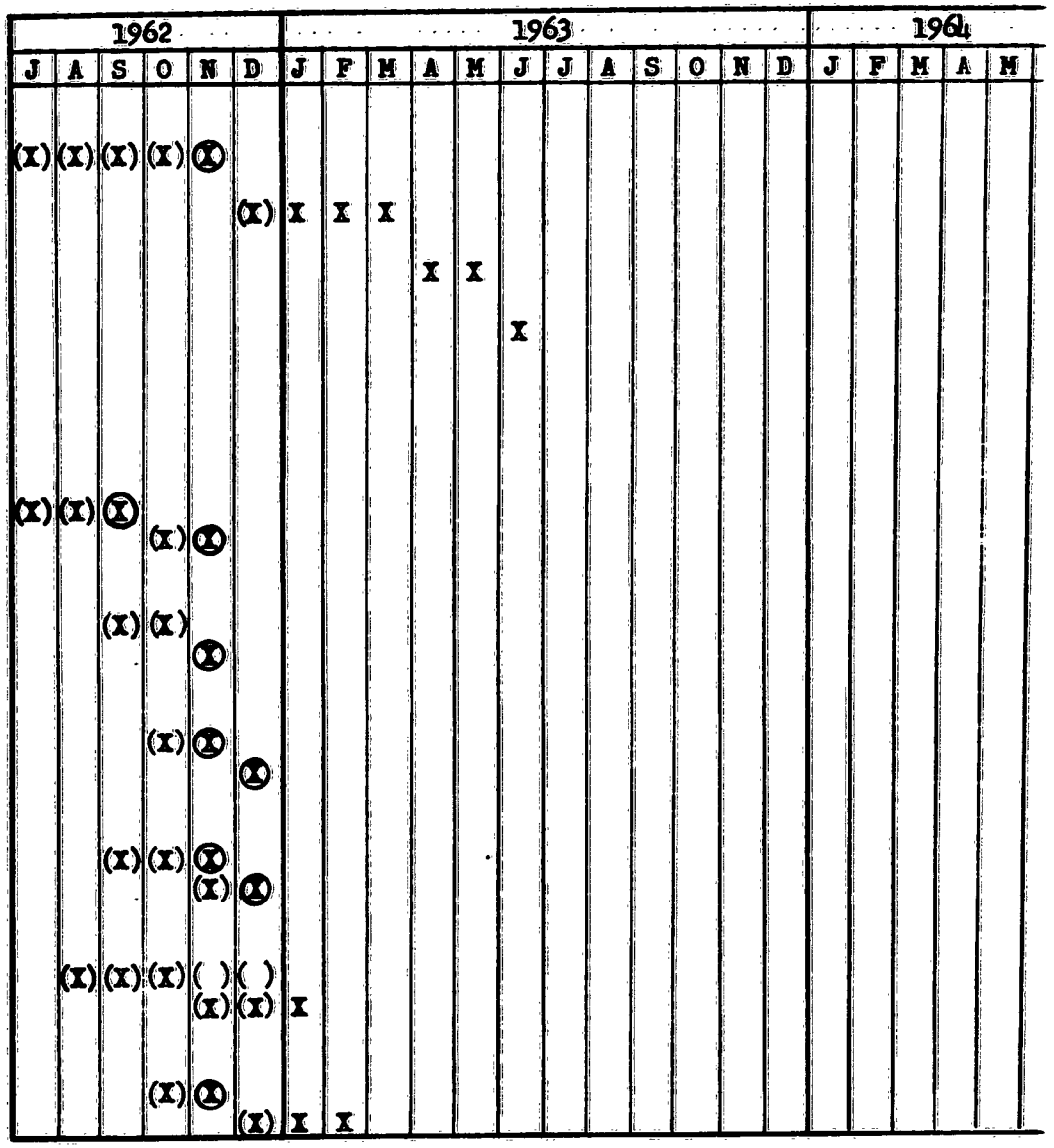
4.0 CONCLUSION

The vacuum exhaust and sealing unit has been ordered. The special test equipment has been completed and tests are being performed with it. The first lot of engineering samples is being tested for delivery on February 19, 1963. Tests on heater design changes have been delayed but may be put back on schedule by an extra effort during January. Final lots designed to test cathode coating techniques should be completed during January. Selection of final spray mask design will be made following life tests on these samples.

5.0 PROGRAM FOR THE NEXT INTERVAL

Periodic checks will be made with the Ultek Corp. to assure progress and delivery by established dates. Additional effort will be directed toward completing tests on heater designs and on spray mask effects. Selection of best design will be made following life testing. Final design spray fixtures will be built. Construction of tubes incorporating design improvements will be started.

5.1 PROGRESS CHART - 7486 PEM
DA.36-039-SC-86738



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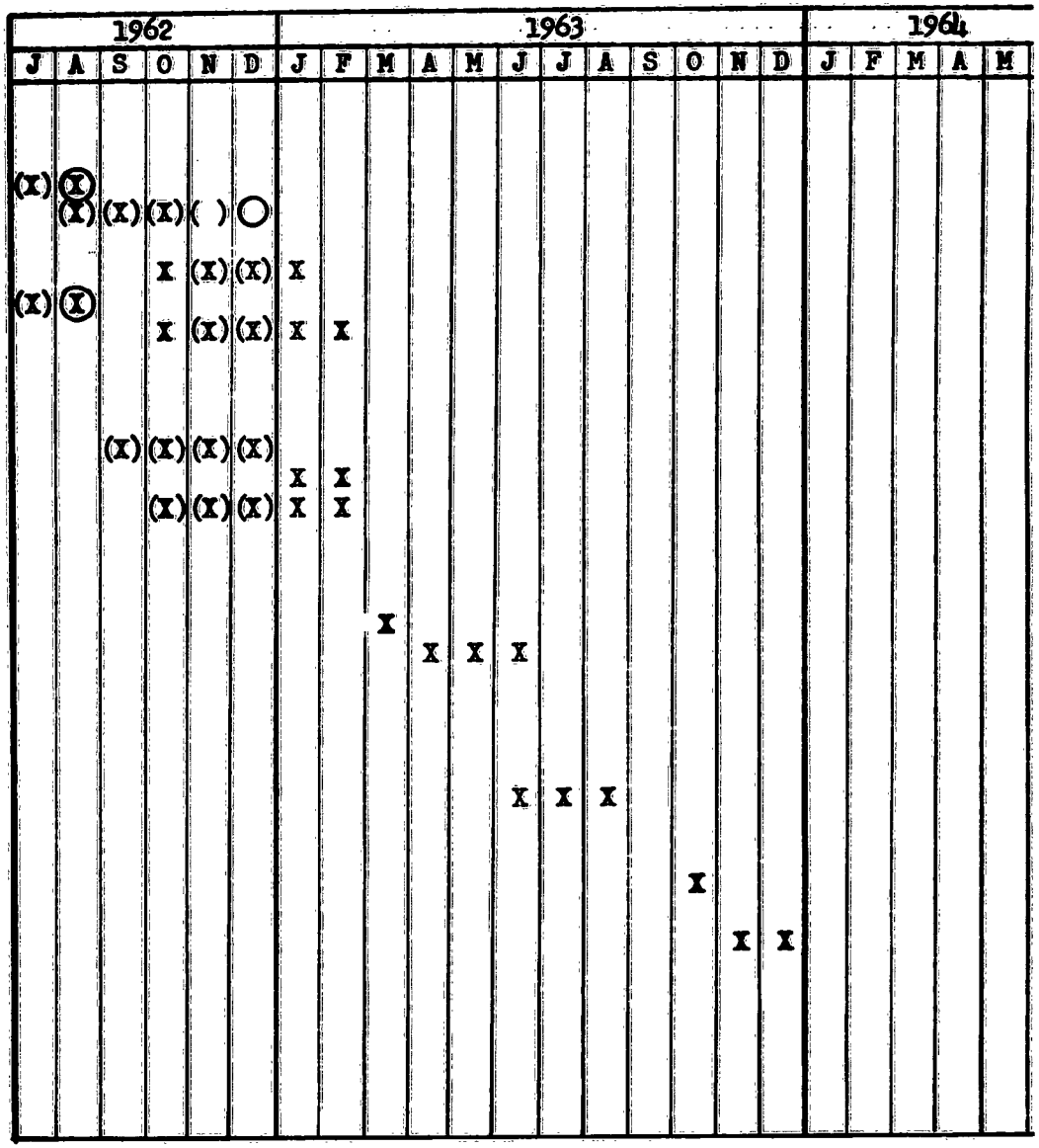

X - Anticipated Progress
( ) - Actual Progress
O - Completed

5.1 PROGRESS CHART - 7486 PEM
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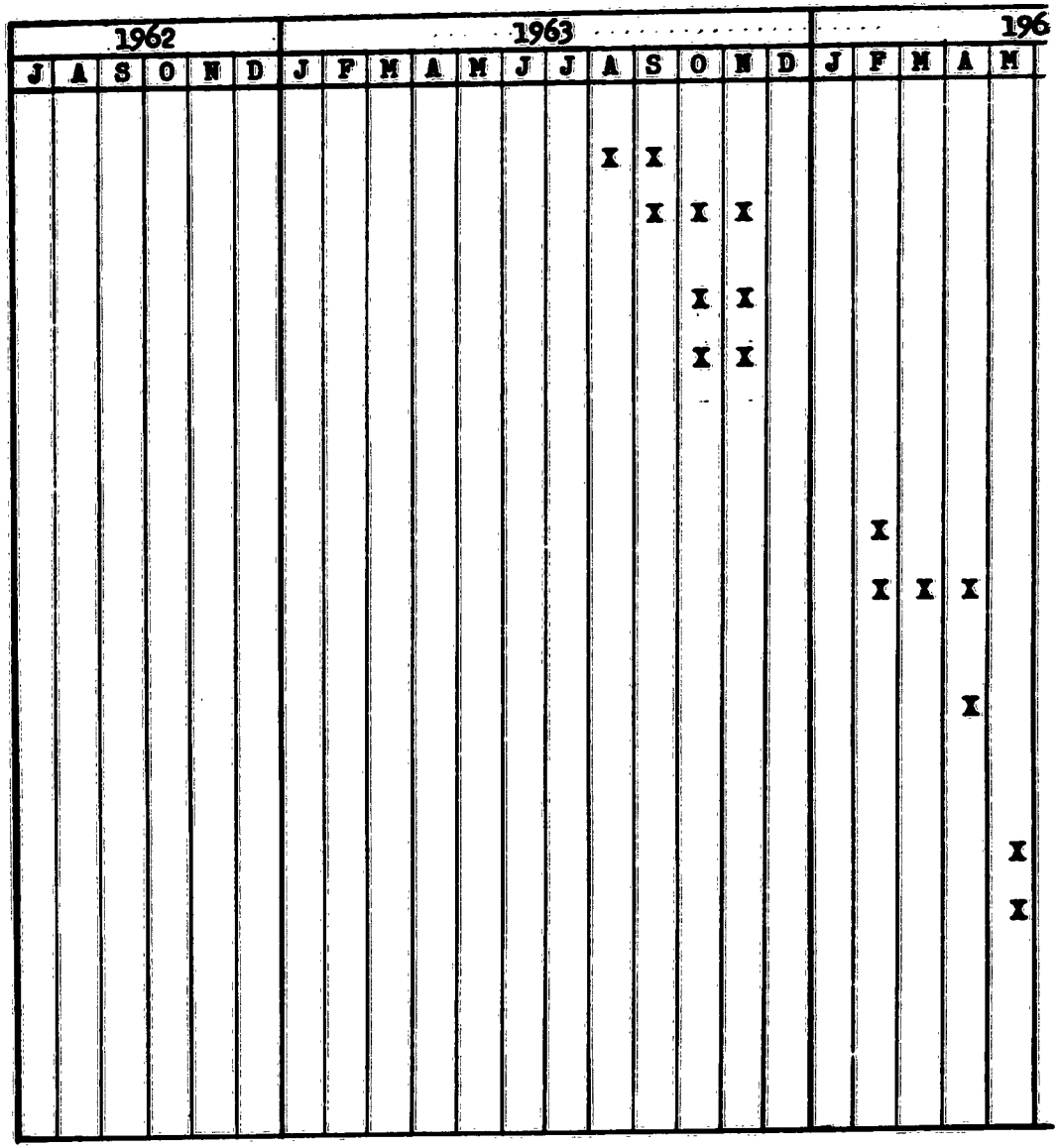

X - Anticipated Progress
Ø - Actual Progress
Ø - Completed

6.0 PUBLICATIONS, REPORTS AND CONFERENCES

6.1 PUBLICATIONS - None

6.2 REPORTS - Monthly Report No. 4
PEM For Tube Type 7486
by J. D. Marshall for the period of
October 1, 1962 to November 1, 1962

Monthly Report No. 5
PEM For Tube Type 7486
by J. D. Marshall for the period of
November 1, 1962 to December 1, 1962

Monthly Report No. 6
PEM For Tube Type 7486
by J. D. Marshall for the period of
December 1, 1962 to January 1, 1963

Quarterly Report No. 1
PEM For Tube Type 7486
by J. D. Marshall for the period of
19 June 1962 through 30 September 1962

6.3 CONFERENCES - None

7.0 PERSONNEL

Time spent on the program during this report period was as follows:

J. D. Campbell	96 hours
J. D. Marshall	194 hours
S. A. Jolly	214 hours
L. F. Jeffrey	170 hours
H. W. Grant	152 hours
J. R. Osborne	10 hours
G. E. Moore	8 hours

Submitted by:

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Planar Tube Product Design
Receiving Tube Department

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Receiving Tube Department

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